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# SOME INSECTS AFFECTING THE PRODUCTION OF RED CLOVER SEED.

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Our knowledge of the two insects here given more special consideration—the clover-flower midge and the clover-seed chalcis—is still somewhat obscure, and particularly so in the case of the latter. In the following pages the effort has been made, not so much to present a finished treatise as to place within reach of the practical farmer, in a condensed form, all available information relative to some of the insects that, in one way or another, affect red clover seed. At the present time cultivation of this valuable crop for seed is frequently attended by losses, more or less serious, or even by total failures, the causes of which are not at all well understood by the agriculturist. Bumblebees, or some similar agency, are necessary to the pollination of the clover blossom. It is possible, however, that many failures of the seed crop heretofore attributed to a scarcity of bumblebees may in reality be due to the destructive work of the insects herein described.

These two insects have been selected both because of their economic importance and also on account of their interrelations, not only with each other—as the presence of one in a floret precludes the existence of the other—but also with other clover insects.

## RELATIONS OF THE TWO INSECTS.

What has until very recently been termed the clover-seed midge is in all probability not a seed-infesting insect at all, but one which attacks the ovaries, probably destroying them before they are fertilized, and certainly before seeds can develop. The clover-seed chalcis lives in the seeds only; therefore, when the first occurs it is impossible for the second to exist.

## INTERRELATIONS WITH OTHER INSECTS.

No influence of the bumblebee can produce seed where its visits to the florets have been anticipated by the maggots of this midge. But the complication does not end here by any means. Another insect, the clover-leaf weevil[1] (fig. 1), a beetle introduced into this country by acci-

[1] *Phytonomus punctatus* Fab.

dent many years ago, probably from Europe, and now known to occur from New England to North Carolina and Wisconsin, attacks the clover plants in spring after they have made some growth and, in cases of excessive abundance, leaves the ground as bare of clover in May as it was in December. It does not, however, injure the roots, and soon the plants spring up and the fields become as green with clover as before, the final result being that only the blooming is retarded. That this delay is fatal to the midge has been shown, again and again, by the heavy crops of seed that have been secured from fields overrun with the weevils in May. A further complication is found in the fact that the

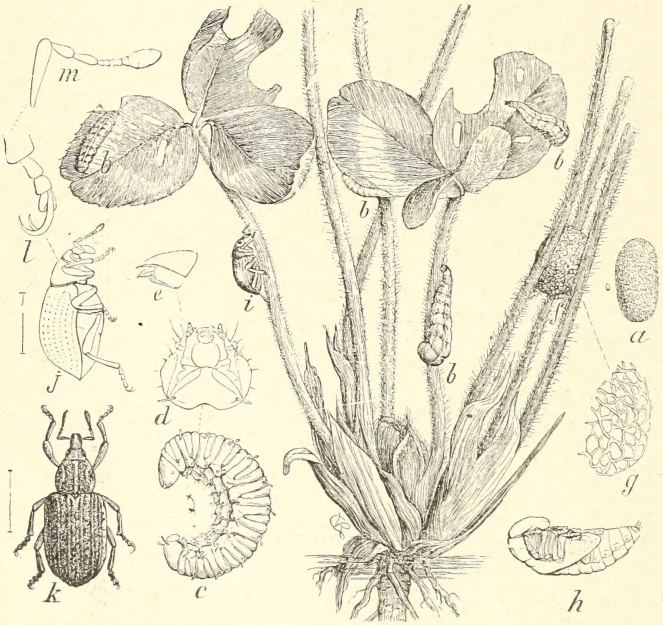


FIG. 1.—The clover-leaf weevil (*Phytonomus punctatus*): *a*, egg; *b*, *b*, *b*, *b*, larvæ feeding; *c*, recently hatched larva; *d*, head of same from beneath; *e*, jaw of same; *f*, cocoon; *g*, meshes of cocoon; *h*, pupa; *i*, beetle; *j*, same, in outline; *k*, same, dorsal view; *l*, tarsus of beetle; *m*, antenna of same (*b*, *f*, *i*, natural size; others more or less enlarged). (From Riley.)

clover-leaf weevil does not become excessively abundant and eat off the clover every spring, because a fungous parasite attacks the larvæ, causes them to die off by myriads, and thus keeps the insect greatly reduced in numbers.

To summarize, the clover-seed chalcis attacks an important seed crop; but the flower midge destroys the ovaries before these have been fertilized by the bees and seed developed, thus checking the chalcis; the leaf weevil, however, eats off the clover plants in spring, so that blooming is delayed until after the midge is obliged to deposit its eggs, thus restricting its breeding; while the insect-destroying fungus keeps

the leaf weevil from subjugating or exterminating the midge, by causing the death of the young weevils.

All of this conflict is going on to a greater or less degree each year in the clover fields of the farmer, and for the most part without his knowledge; nevertheless he is a gainer or a loser in proportion as each insect increases or decreases in abundance. A knowledge of these conditions will better enable him to devise practical means to protect his crop and avoid loss.

## THE CLOVER-FLOWER MIDGE.

(*Dasyneura* [*Cecidomyia*] *leguminicola* Lint.)

This minute insect, shown in figures 2 and 3, is a near relative of the wheat midge,[1] which it resembles in form and color. The larva, or maggot, also bears a similar resemblance in shape and color; hence farmers, in searching for the clover-flower midge, should look for something very like what has been long, though erroneously, known as the "red weevil" in wheat, and will frequently find it in sufficient abundance among the hulled clover seed to attract their attention. In drawing in clover hay these maggots are frequently shaken from the cured blossoms in such numbers that the bottoms of the wagon racks become literally covered with their reddish bodies.

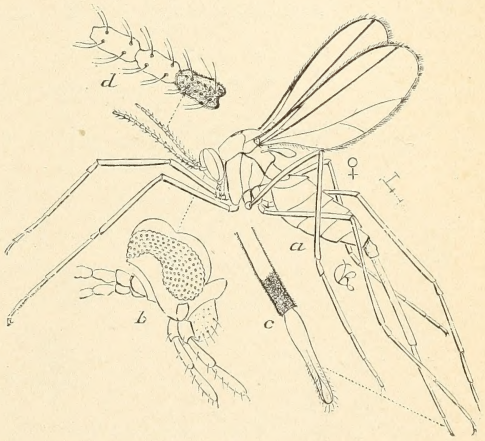


FIG. 2.—The clover-flower midge (*Dasyneura leguminicola*): *a*, enlarged side view of female, with scales denuded, to show more clearly the structure; *b*, head, more highly magnified, to show structure of the eye, palpi, and basal joints of antennæ; *c*, tip of ovipositor, highly magnified and showing at end of next to last joint the manner in which it is clothed with minute hair; *d*, highly magnified antennal joints, their minute hairy clothing shown on the lower one. (From Riley.)

### DESCRIPTION.

*The adult* insect (fig. 2, female; fig. 3, male) is a minute two-winged fly. The head and thorax are black, the latter clothed with rather long hairs. The antennæ are long, those of the female (fig. 2) sixteen or seventeen jointed and those of the male (fig. 3) fifteen-jointed. The wings are nearly transparent and clothed with numerous short, curved, blackish hairs, giving them a dusky appearance, each wing having three longitudinal veins, the third vein being either forked or more or less obsolete toward the tip. The wings are also fringed with hairs that are longer and paler than those on the surface. The abdomen of the female

[1] *Contarinia* (*Diplosis*) *tritici* Kirby.

(fig. 2) is reddish, with black hairs on the back of each segment. The abdomen of the male (fig. 3) terminates with a pair of clasping organs, while that of the female is provided with a long, pointed, extensile ovipositor, about twice as long as the remainder of the body.

*The egg* is only about one one-hundredth of an inch long, oval, about three times as long as broad, pale yellow when first deposited, but becoming tinted with orange as it nears hatching.

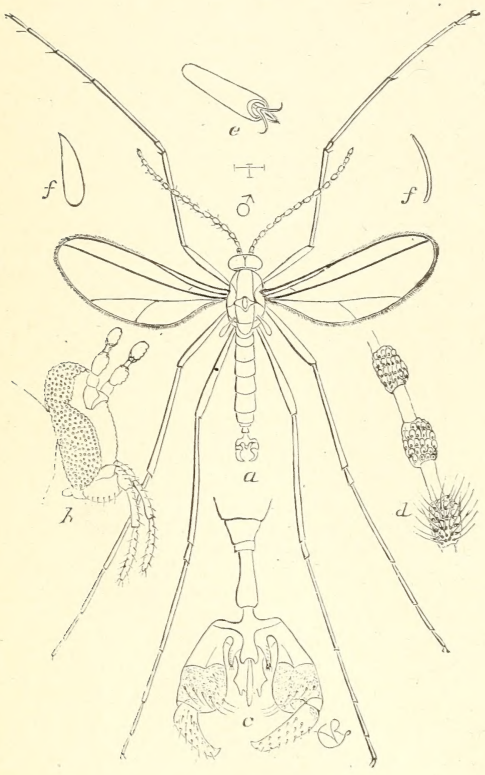


FIG. 3.—The clover-flower midge (*Dasyneura leguminicola*): *a*, enlarged dorsal view of male with scales denuded; *b*, head; *c*, genitalia; *d*, antennal joints, more highly magnified, to show structure; *e*, tarsal claw; *f*, *f*, forms of scales. (From Riley.)

*The larva* (fig. 4) when full grown is about one-twentieth of an inch long, footless, ranging in color from nearly white to orange-red, according to age.

*The pupa* is pale orange in color, with brown eyes. On the front of the head are two short, conical tubercles, and behind them two long bristles. The sheaths inclosing the antennæ are curved outward like the handles of an urn.

## LIFE HISTORY.

The pupa is inclosed in a compressed, tough, oval silken cocoon, and when the fly is ready to emerge the pupa pushes itself out of this cocoon to the surface of the ground.

It is within the cocoon that the winter is passed, and the time in spring when it comes forth as an adult varies with the latitude and season, probably closely corresponding to the heading of red clover.

After pairing, the female proceeds to deposit her eggs in the clover head, pushing them beneath the bracts or enveloping leaves, or down between, but not fastening them in any way to the seed capsule, and in no case, so far as observed, within the florets. Although deposited singly, Professor Comstock reports as many as 50 eggs in a single head.

In hatching, the larva must make its own way into the open end of the floret, which offers only sufficient quarters for one individual. In this floret it feeds, and from it, when full grown, it makes its exit and

drops to the ground, into which it usually descends a short distance. Here it forms a tough silken cocoon, to which particles of earth adhere, giving it the superficial appearance of a little lump of soil. From the cocoons the adults emerge in time to oviposit in the second or seed crop of bloom, and the same mode of procedure is gone through with again, except that this time the insect hibernates in the cocoon and the midges do not appear until the following spring.

It will thus be observed that there are two annual generations, the flies appearing simultaneously with the first and second blooming periods of the clover. While they thus appear earlier in the South than in the North, it is doubtful if there are more than two broods throughout the area over which red clover (*Trifolium pratense*) is grown, though the broods may be more prolonged or widely separated to the southward.

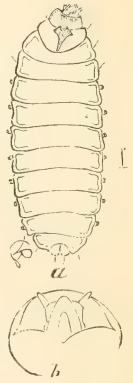


FIG. 4.—Clover-flowermidge: *a*, larva enlarged, ventral view; *b*, head retracted, highly magnified. (Riley.)

### EFFECT UPON THE PLANT.

There is no material effect on the stem or foliage, but the heads quickly indicate the presence of the maggots by failure of the florets to develop, becoming reduced in size, often distorted, and lacking the familiar pinkish color more or less. In fact, the abundance of the pest may be approximately estimated by the appearance of a clover field during the blooming season.

### DISTRIBUTION.

Although the pest did not attract more than local attention until 1878 and was not described until a year later, there is considerable evidence indicating that it was injurious in New England at least thirty years prior to these dates. Dr. S. A. Forbes, also, found good evidence of its occurrence in Illinois at about the time of its discovery in New York by Lintner. One of the writer's assistants, Mr. G. I. Reeves, found it occurring in Nebraska in destructive abundance in 1904, though Prof. Lawrence Bruner did not know of its occurrence in that State in 1898. The late Miss Ormerod reported its occurrence in England in 1890 and stated that it had probably been present in the clover fields there for several years. In America it probably occurs wherever mammoth, crimson, white, or the common red clovers are grown.

### NATURAL ENEMIES.

One of the first parasites to be reared was bred in 1879, at Washington, D. C., from material sent from New York. It is a minute black four-winged fly[1] which the writer reared also from the larvæ of the wheat

[1] *Anopedias error* Fitch, family Platygasteridæ.

midge in Indiana in 1884. It does not finish its transformation until after the maggots have left the clover heads and constructed their cocoons in the ground, and therefore emerges from the cocoons and not from the clover heads.

Two species of Tetrastichus, both small, mostly black or bronze-colored four-winged chalcidid flies, were reared in immense numbers in the spring of 1905 from clover heads collected about Lincoln, Nebr., during the preceding December. In this case the adult parasites were reared from both larvæ and pupæ taken in midwinter from infested clover heads, and their abundance is an indication of their efficiency in destroying the midge.

## PREVENTIVE MEASURES.

Fortunately there are two equally efficient and practical measures that can be applied, each to different field conditions. If the meadow to be protected consists of clover alone, and not a mixture of clover and timothy, the hay should be cut quite early, not later than the second week in June, in ordinary seasons. In the latitude of northern Ohio, Indiana, and Illinois this will be just before timothy is headed, but, of course, the date will be earlier to the south and later to the north. As clover alone will stand earlier harvesting without injury to the hay crop, this method is entirely feasible; and it seems either to destroy the larvæ of the midge or to so hasten the second blooming that, by the time the second or fall brood of midges appears the blossoms have become too far advanced for the maggots to work in them.

The second measure can be applied where, as is more often the case in the Middle West, timothy and clover are grown together. While dairymen and cattlemen prefer clear clover hay, horsemen prefer timothy with little or no clover. Besides, in some sections of the country, the clover seems to gradually displace the timothy, while in others the reverse is the case, the relative proportions of each being, therefore, more or less unstable. In such cases it is understood by the farmers that a mixed meadow with much timothy needs to stand longer before mowing than in case of clover alone, a condition that can be effectually met by pasturing meadows lightly or running a mower over them and clipping back the growth—probably not later than the middle of May to the south, while Doctor Fletcher, in Canada, states that in his northern latitude it must be done not later than June 20. This treatment of a meadow of clover and timothy combined only checks the growth temporarily, precisely as does the work of the clover-leaf weevil, so that both first and second blooming of the clover portion come too late for the destructive work of the midge, and the hay crop, as a whole, sustains no loss. This retardation may slightly delay the haying in meadows so treated, but this hay can be cut while the timothy is in bloom or afterwards, as suits the desire of the owner.

In putting either one of these methods into practice, the farmer will have to use his own judgment as to exact dates, as seasonal influences affect both the time of blooming of the clover and the appearance of the midges. He must also see to it that roadsides and margins of fields are prevented from becoming nurseries for the midge, from which they may easily migrate to his fields.

### THE CLOVER-SEED CHALCIS.

(*Bruchophagus funebris* How.)

The differences between this insect and the preceding have already been pointed out. Its habits are decidedly anomalous. It belongs to a family of parasites whose office it is to prey upon and destroy other insects; and it was largely this conception of its mode of living that caused it to be first described as a parasite of the clover-flower midge, and thus to be looked upon as a friend of the farmer instead of as an enemy. This opinion was universal up to 1896, when Dr. A. D. Hopkins, then of West Virginia, called attention to the misconception, but even at that late date his conclusions were not generally accepted as correct. Since that time, however, the insect has again and again been proven, by rearing, to be a vegetable feeder, by investigators within this Bureau and by others, until there can no longer be a shade of doubt regarding its clover-seed-destroying habits. Both this and the midge may inhabit the same heads of clover, but not the same florets.

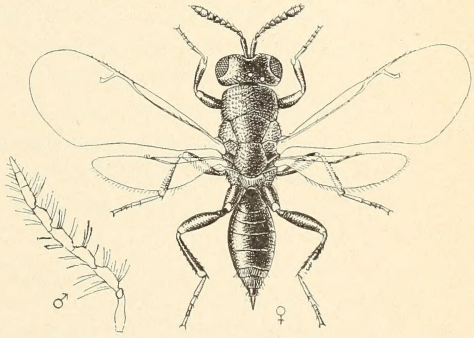


FIG. 5.—The clover-seed chalcis (*Bruchophagus funebris*): Adult female, much enlarged; antenna of the male at left, more enlarged. (Original.)

### DESCRIPTION.

*The adult* insect is shown enlarged in figure 5. It is of small size, compact form, and general black color, with dark-brown eyes, and with the lower portion of the fore legs and all the feet light brown.

*The egg* (fig. 6) is whitish, smooth, polished, slightly elongate, with a long, slender pedicel. It is deposited directly in the otherwise perfect seed.

*The larva* (fig. 7) is of much the same color as the egg and when full grown practically fills the empty shell of the seed, the contents of which it has consumed.

*The pupa* (fig. 8) is at first whitish, but later changes to brown. It develops to the adult within the seed and in this last stage eats its way out of the now empty seed shell.

## LIFE HISTORY.

It is probable that the insect passes the winter in the seed within outstanding clover heads in the field, and it may do so either as larva or pupa.

Doctor Hopkins and Mr. E. S. G. Titus, both of whom have witnessed oviposition, state that the female crawls down among the florets and pushes her egg into the seed, which at this time is in a semifluid state. As this is practically the condition of the seed until it becomes full sized and begins to harden, it is not yet clear just how the larva feeds during this time, but in all cases the larva develops within the seed, and from it the adult emerges. Mr. Titus found that a larva sometimes abandons one seed and, eating its way through the inclosing floret into an adjoining one, enters another seed. In one instance observed, a single larva appeared to have in this way reached and partly devoured three seeds. This would account for the shrunken or partly developed seeds, frequently charged up to the midge. Developing within the seed, it seems probable that the adults issue therefrom at the usual time when the seed of the second bloom has begun to form, and that the same mode of procedure is followed as before, except that the adults from these seeds do not appear until late in the following spring or early in the summer. While future investigations may necessitate modifications of this supposed life cycle, it will probably be found, in the main, correct, and, if so, it would seem that the less number of seeds produced by the first bloom might act as a restraint upon the excessive abundance of the insect in the second. However, as cases are known in which from 50 to 85 per cent of the seeds of a single head were infested, it will readily be seen how serious a pest it can become in the clover field with no other restraint put upon its increase. Its presence is most assuredly never beneficial.

FIG. 6.—The clover-seed cha'cis: Egg, highly magnified. (Original.)

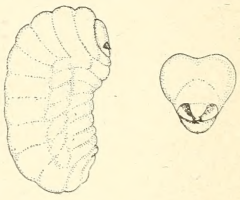

FIG. 7.—The clover-seed chalcis: Larva, much enlarged; head at right, more enlarged. (Original.)

FIG. 8.—The clover-seed chalcis: Pupa, much enlarged. (Original.)

### FOOD HABITS AND EFFECTS UPON THE PLANT.

The food plants are known to include the seed of red and crimson clovers and alfalfa.

There appears to be no visible effect upon any part of the plant attacked except the seed. Even badly infested heads can not be distinguished from those uninfested. At present it seems that a serious loss to the clover-seed crop may be caused by this insect, without the farmers being in any way able to account therefor, as the shriveled and imperfect seeds are mostly

blown out with the chaff in hulling, as are also more or less of those infested.

### DISTRIBUTION.

The insect is known to occur from New England to Oregon, Washington, and California on the west, and south to Mississippi; and, in fact, it may be confidently looked for wherever its food plants are grown.

### NATURAL ENEMIES.

While parasites have been frequently reared from infested clover heads, it is as yet impossible to say whether they had preyed upon this or some other insect occurring with it.

### PREVENTIVE MEASURES.

While it would seem that the same measures recommended for the flower midge might apply to this insect, more careful study and experimentation than have yet been given the subject will be necessary before we can secure definite assurance that this is so.

If all outstanding clover heads were destroyed and the chaff and stems burned after hulling, this would in all probability greatly reduce its numbers the following year, even if it did not exterminate it.

Approved:

JAMES WILSON,
*Secretary of Agriculture.*

WASHINGTON, D. C., *April 12, 1906.*

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